Wind and Seismic Effects

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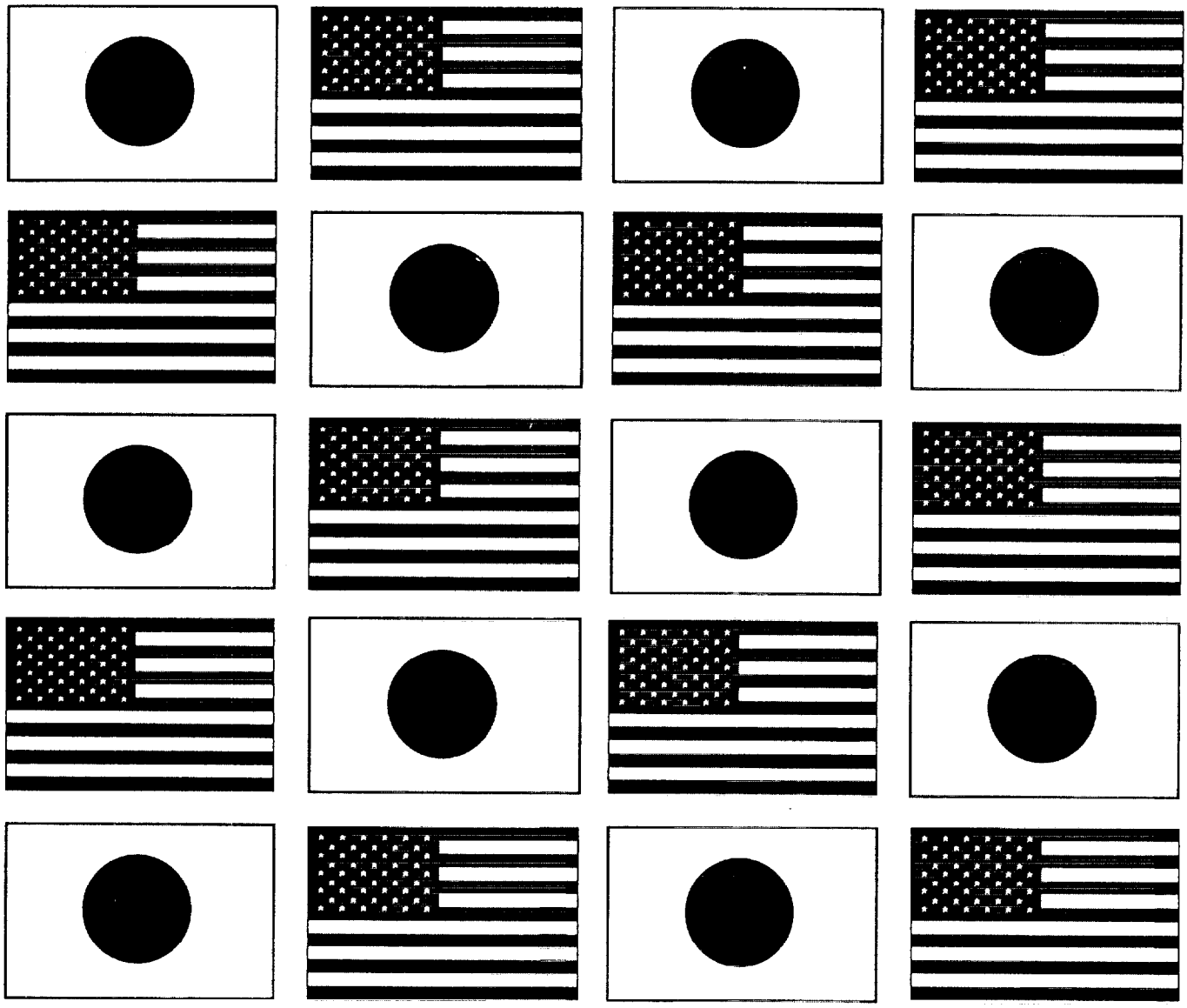

U.S. DEPARTMENT OF COMMERCE
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PROCEEDINGS OF
THE 30TH JOINT
MEETING OF
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PANEL ON WIND AND
SEISMIC EFFECTS

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STORM SURGE and TSUNAMIS

International Responses to Pacific Tsunami Warnings and Watches

by

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ABSTRACT

The Pacific Tsunami Warning Center has issued thirteen warnings to the participants in the Tsunami Warning System in the Pacific since the beginning of the International Decade for Natural Disaster Reduction. The average time for the dissemination of these warnings has been about 55 minutes. In most cases tsunami destruction has been confined to localities that are within one hour's tsunami travel time from the source. While the Warning Center's warnings may not reach those most affected by reecent tsunamis, the information is nevertheless of great value to those emergency managers further down stream of the spreading tsunami. An examination of the warning process indicates the need for more feedback from the participants receiving the warnings regarding the applicability of the information to their needs and, if they are affected by the tsunami, a timely summary of these affects that can be used to ascertain the severity of the tsunami. The study also points up the critical need for independently functioning regional tsunami warning centers.

KEYWORDS: destructive tsunamis, emergency managers, feedback, response, tsunami warning, tsunami watch

1. INTRODUCTION:

Since the beginning of the International Decade for Natural Disaster Reduction (IDNDR) the Pacific Tsunami Warning Center (PTWC), acting as the Operations Center for the Tsunami Warning System in the Pacific (TWSP), issued 13 warnings for earthquakes that were believed to have the potential to generate tsunamis. These events are summarized in Table 1. It was further believed that these tsunamis could be destructive in the Pacific beyond the earthquake macroseismic area. In nearly every case the tsunamis that were generated proved to be either non-destructive or non-existent in the far field. All 13 earthquakes for which warnings were issued resulted in at least a local tsunami. Some of these caused significant loss of life and property damage.

2. TSUNAMI WARNING ISSUANCE

The average time from earthquake origin time to the issuance of a warning for these events is fifty-five minutes. Information on the timing of warnings issued is found in Table 2. The issuance time ranges from 34 minutes to 92 minutes after the origin time. This range is affected by two factors: an organizational relationship with a regional warning center responsible for issuing tsunami warnings to the northeast Pacific region within 15 minutes and

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the time necessary to acquire and interpret the seismic waves necessary to determine the size of the potentially tsunamigenic earthquake.

3. TSUNAMI SEVERITY

In most cases the destructiveness of a tsunami is confined to areas that are within one hour's tsunami travel time of the origin of the tsunami. A summary of some of the runup (R) and water level gauge (G) data for the warning events may be found in Table 3. In Table 3 runup values are in meters and gauge data are in centimeters, peak-to-trough. While the data do not necessarily reflect uniform fall off of tsunami heights with increasing distance from the source, it can be seen that in nearly every case tsunami heights are below 1.5 meters, a height that may be take as the threshold of minimum tsunami destruction, for sites away from the source. Anotable exception is the two meter runup observed at Hiva Oa where boats were swamped by the tsunami from the northern Chile earthquake of 30 July 1995.

4. CONCLUSIONS

Although, on the average, the warnings issued by the PTWC do not reach those most affected by the tsunami in time, the warnings are useful to those who are a few hours tsunami travel time from the source. This is because the warnings provide important input for emergency managers in this zone. They must make critical decisions on the appropriate action to take regarding the potential tsunami that is soon to arrive in their areas of responsibility.

With the exception of feedback received from emergency managers in the United States, the home country of the PTWC, little is known concerning the actions taken by those who were warned about the 14 events occurring thus far in the IDNDR. Japan, which has a highly developed regional tsunami warning system, routinely informs the PTWC of warnings it issues to its citizens. Discussions with emergency managers from other areas indicate that there is a wide range of responses to the warnings. These range from doing nothing because historically only very great distant earthquakes have ever caused damage in a particular region to ordering coastal evacuation for all tsunamigenic events, without regard for the earthquake magnitude, upon receipt of the warning.

The results of this study indicate there is a critical need for more regional tsunami warning systems in those areas most susceptible to local tsunamis. This need was expressed earlier in the IDNDR by the Japan Meteorological Agency in their report on the mitigation of tsunami disasters (JMA, 1993). It also finds there is a need to formalize a process of feedback between those closest to the source of the expanding tsunami and the PTWC. In this way the TWSP operations center can better assess the severity of the tsunami and provide better information to those who are further away from the approaching tsunami. There is also a critical need for the operations center to acquire both seismic and water level data in at least near real time from sites close to the major tsunami source areas. These data will allow the PTWC to assess more quickly the size of the potentially tsunamigenic earthquake and the severity of the tsunami it generates.

5. REFERENCES

Japan Meteorological Agency, *The Study Report on the Mitigation of Tsunami Disasters in the Pacific Basin Countries*, March 1993, 58 pages.

No.	YrMoDy	OT (UTC)	Lat.	Long.	Ms	Mw	Geographic Location
1	930712	1317	42.3N	139.4E	7.6	7.7	Japan, West of Hokkaido
2	930808	0834	13.0N	144.8E	8.0	7.8	Marianas Islands, South of Guam
3	941004	1323	43.7N	147.3E	8.1	8.3	Russia, Southern Kuril Islands
4	950407	2207	15.2S	173.6W	8.0	7.4	Northern Tonga Islands
5	950516	2013	22.9S	169.9E	7.7	7.7	New Caledonia, Loyalty Islands
6	950730	0511	23.4S	70.4W	7.3	8.0	Near Coast of Northern Chile
7	950816	1027	05.6S	153.9E	7.8	7.7	Papua New Guinea, Nr. Bougainville I.
8	951203	1801	44.6N	149.4E	7.9	7.9	Russia, Southern Kuril Islands
9	960217	0600	00.1S	137.0E	8.1	8.2	Indonesia, Irian Jaya Region
10	960610	0403	51.4N	177.8W	7.6	7.9	Alaska, Aleutian Islands, Andreanof Is.
11	960610	1526	52.4N	176.9W	7.1	7.3	Alaska, Aleutian Islands, Andreanof Is.
12	970421	1202	12.6S	166.7E	7.9	7.8	Vanuatu, Northwest of Torres Islands
13	971205	1127	55.9N	161.9E	7.6	7.9	Russia, Kamchatka Peninsula

Table 1. Earthquakes in the IDNDR through December 1997 for which the PTWC issued RWWs and a Pacific-wide Warning

No.	OT (UTC)	First Bull.	Mins. past OT	Supps.	Last Bull.	Total Warn Time
1	1317	1412	55	1	1457	0h45m
2	0834	0908	34	2	1145	2h37m
3	1323	1445	82	5	2150	7h05m
4	2207	2244	37	2	2322	0h38m
5	2013	2111	58	2	2300	2h49m
6	0511	0643	92	1	0750	1h07m
7	1027	1119	52	2	1354	2h35m
8	1801	1847	46	2	2101	2h14m
9	0600	0658	58	1	0081	1h13m
10	0403	0440	37	1	0541	1h01m
11	1526	1624	58	1	1643	0h19m
12	1202	1304	62	2	1444	1h40m
13	1127	1209	42	2	1351	1h42m

Table 2. Information on RWWs issued by the PTWC. Note: A Pacific-wide warning was issued for Event No. 3.

930712	930808	941004	950407	950516
R31 SW Okushiri I.	G98 Shikoku	G346-26 Hokkaido	G30 Pago Pago	G40 Port Vila, Vanuatu
R10 W Hokkaido	G68 Bonin Is.	G300 Yuzhno-Kurilsk	G05 Niue	G10 Pago Pago
R03 Russia	G56 Kyushu	G162 Bonin Islands		G06 Fiji
R02 NE South Korea	G19 Guam	G130-42 Honshu		G03 Apia, Samoa
R01 Aomori, Honshu	G19-5 Hawaii	G50 Midway		G03 Tonga
		G48 Hilo, Hawaii		G03 Raratonga, Cook I.
		G17 Wake		
		G17 Pago Pago		
		G15 Shemya, Alaska		

950730	950816	951203	960217	960610
G75 Hilo, Hawaii	G55 Rabaul, PNG	G41 Midway	R7 Biak I., Irian Jaya	G102 Adak, Alaska
G70 Kahului, Hawaii	G10 Kwajalein	G37-10 Hokkaido		G55 Kahalui, Hawaii
G55 Valparaiso, Chile		G31 Crescent City		G46 Midway
G30-9 Alaska		G20 Shemya		G38 Hilo, Hawaii
G29-26 Honshu		G13 Wake		G33 Nawiliwili, Hawaii
G27-10 California		G13-6 Honshu		G30 Crescent City
G25 Pago Pago		G10 Adak, Alaska		G15-10 Aleutians
G12 Nawiliwili, Hawaii				G10 Honolulu, Hawaii
G10 Easter Island				G10 Port Angeles
G09 Papeete, Fr. Poly.				
R2 Hiva Oe, Fr. Poly.				

960610	970421	971205
In coda of main tsunami on several mareograms with about half the amplitude of the main tsunami.	R3 Santa Cruz Is.	G15 Aleutians, Alaska

Table 3. Runup (R) in meters and Water Level Gauge (G) in centimeters tsunami measurements for warning events.